REMARKS

In the Specification

The Applicant has made a number of amendments to the specification. These amendments clarify and unify the language of the specification, making it easier to understand. The Applicant submits that none of the amendments to the specification add any new matter.

In the claims

Claims 1-64 are now pending in this application.

Claims 22-26 are allowed.

Rejections under 35 USC § 112

The Examiner has rejected claims 1-21 under 35 USC § 112 as being indefinite. Specifically, the Examiner expresses the view that the phrase "deforming membrane in a concave fashion" (as used in claim 1) and the phrase "transparent membrane being deformable to vary by said deformation the extent of refraction" (as used in claim 14) are meaningless and indefinite. The Examiner has rejected claims 2-13 because they depend from claim 1. The Examiner has rejected claims 15-21 because they depend from claim 14.

The Applicant has amended claims 1 and 14 for clarity. In claim 1, the Applicant has replaced the phrase "deforming membrane in a concave fashion" with the phrase – inducing a deformation of said membrane, thereby increasing a thickness of a first one of said refractive regions and correspondingly decreasing a thickness of a second one of said refractive regions.-- In claim 14, the Applicant has replaced the phrase "said transparent membrane being deformable to vary by said deformation the extent of refraction" with the phrase --wherein an amount of deformation of said transparent membrane determines an amount of refraction caused to a light beam transmitted by said adaptive lens.-- The Applicant submits that amended claims 1 and 14 comply with 35 USC § 112.

The Applicant has also made minor clarifying amendments to claims 7-12, 15, 20 and 21.

As claims 2-13 depend from amended claim 1 and claims 15-21 depend from amended claim 14, the Applicant submits that claims 2-13 and 15-21 comply with 35 USC § 112.

Objections under 37 CFR § 1.75

The Examiner has objected to claims 10-13, 21 and 28-31 under 37 CFR § 1.75 because a multiply dependent claim should refer to other claims in the alternative only, and/or, cannot depend from any other multiply dependent claim.

The Applicant has amended claims 9, 20 and 27 to remove their multiple dependencies and to make minor clarifying amendments.

The Applicant has made minor clarifying amendments to claims 10, 11 and 12. Claims 10-13 depend from amended claim 9, which now depends only from claim 1. Accordingly, the Applicant submits that claims 10-13 now comply with 37 CFR § 1.75.

The Applicant has made minor clarifying amendments to claim 21. Claim 21 depends from amended claim 20, which now depends only from claim 14. Accordingly, the Applicant submits that claim 21 now complies with 37 CFR § 1.75.

The Applicant has made minor clarifying amendments to claim 28. Claims 28-31 depend from amended claim 27, which now depends only from claim 22. Accordingly, the Applicant submits that claims 28-31 now comply with 37 CFR § 1.75.

Rejections under 35 USC § 102

The Examiner has rejected claims 1, 2, 14 and 15 under 35 USC § 102 as being anticipated by Goossen (US Patent No. 5,825,528). The Applicant submits that Goosen fails to anticipate the invention as recited in any of the Applicant's claims.

As understood by the Applicant, Goosen teaches a ***reflective*** apparatus for modulating an optical signal and a method for fabricating such a ***reflective*** apparatus. The Goosen apparatus comprises a membrane supported over an ***air gap*** located between the membrane and a substrate. Under the action of bias, the membrane moves vertically from a first position to a second position relative to the substrate, changing the air gap. The ***reflectivity*** of the modulator changes as the air gap changes. Parameters, such as the membrane thickness and the amount of ***air gap***, are suitably selected to achieve zero overall ***reflectivity*** in one of the two membrane positions.

Goossen teaches a *reflective* device, as is evident by the language at column 2, lines 41-46, "The reflectivity of the modulator changes as the membrane moves from its unbiassed position. The change in reflectivity facilitates modulating the optical signal. Membrane thickness and the modulator air gap are suitably selected to achieve zero overall modulator reflectivity in one membrane position." Goossen fails to teach or suggest a ***transmissive device***.

Specifically, Goossen fails to disclose or suggest a "method for varying a direction of a beam of light ***passing through*** a micro-machined device" as recited in amended claim 1. Goosen also fails to disclose or suggest "An adaptive ***lens*** ... wherein an amount of deformation of said transparent membrane determines ***an amount of refraction caused to a light beam transmitted by said adaptive lens***" as recited in amended claim 14.

Goossen teaches an ***air gap***, the thickness of which is adjusted by deforming a membrane. Accordingly, the Goossen device has air on both sides of the deformable membrane. Goossen fails to disclose or suggest a ***transmissive device***, wherein the deformable membrane separates ***two refractive regions***, each of which comprises a ***fluid having a different refractive index***.

Specifically, Goossen fails to teach or suggest "directing a light beam through a transparent membrane separating ***two refractive regions***, each of said refractive regions comprising a ***fluid with a different refractive index*** ..." as recited in amended claim 1. Similarly Goosen fails to teach or disclose "An adaptive lens ... comprising a deformable transparent membrane separating ***two refractive regions***, each of said refractive regions comprising a ***fluid with a different refractive index*** ..." as recited in amended claim 14.

For the above reasons, the Applicant respectfully submits that Goossen fails to anticipate the invention as recited in amended claims 1 and 14.

As claim 2 depends from amended claim 1, the Applicant submits that Goossen fails to anticipate claim 2. As claim 15 depends from amended claim 14, the Applicant submits that Goossen fails to anticipate claim 15.

Accordingly, the Applicant submits that all of claims 1, 2, 14 and 15 patentably distinguish Goossen.

<u>New claims</u>

The Applicant has added new claims 32-65. The Applicant submits that new claims 32-65 are fully supported by the specification and contain no new matter.

The Applicant further submits that new claims 32-65 are novel and inventive in relation to the prior art of record and are in condition for allowance, which is respectfully requested.

Conclusions

In view of all of the amendments and arguments presented above, the Applicant submits that this application is now in condition for allowance and respectfully requests reconsideration and allowance of this application in light of the foregoing amendments and comments.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Description

Paragraph under the heading "Cross-references to related applications" on page 1:

> [1.] This application is related to co-pending, co-owned United States Patent Application No. 09/813,839, entitled "Method for linearization of an actuator via force gradient modification", [US Patent Application 09/813839,] filed March 22, 2001.

Paragraph under the heading "Field of the invention" on page 1:

> The invention pertains to optical communications and in particular to the control of optical [light] beams using adaptive optical elements.

First full paragraph on page 2:

> The field of communications has benefited enormously from the introduction of optical communications technology. Fundamentally, this technology exploits the inherent bandwidth potential of the light itself as a carrier for communications signals. As this technology matures, the need for the direct optical processing of the signals is becoming greater. Much of the communications infrastructure in operation in the field today relies on signals being converted from optical form back to electrical form for much of the signal processing and management. Direct optical processing has the benefit of avoiding the need for [such] optical to electrical and electrical to optical conversion equipment with its associated costs, losses, and amplification requirements.

Second full paragraph on page 2:

> One of the critical issues within the field of optical communications [is reduced on] relates to the situation [when] where many optical signal channels on parallel fibers have to be controlled, adjusted, or switched at a single point in the communication system. This [drives the] issue creates a corresponding need for a microelectronic device with a considerable level of device integration and individually adjustable channels. Simultaneously, there is a clear need for devices that will perform these functions [whilst] while being rapidly adjustable in operation. [Candidate] It is also desirable for candidate devices [are expected] to have relatively low insertion losses and [the lowest] a minimum possible wavelength dependence.

Third full paragraph on page 3:

> One of the fundamental building blocks of an optical communications system is the optical cross-connect or optical crossbar switch. [These devices] Optical crossbar switches function to selectably connect any one of an array of incoming optical signals to any one of an array of outgoing channels. Inherently these devices consist of a multiplicity of optical communications channels [that are often] which may be implemented on [one] a semiconductor [device] wafer using micro-machining technology.

First full paragraph on page 3:

A variety of specific individual device structures have been proposed and fabricated to address [this] the above-described application. [While many] Many of these devices rely on non-linear optic materials to obtain switching actions. [, a very] Another popular way to [achieve this end at the time of this application for letters patent] address the above described application is by means of micro-electromechanical structures. These micro-electromechanical structures are usually micro-mirror devices that tilt, flex, or flip upon application of an appropriate control voltage.

Third full paragraph on page 3:

The small apertures involved in the light-carrying cores of the optical fibers, particularly single mode fibers, lead to considerable beam divergence. [This] Divergence is typically addressed [via] by using suitably small micro-lenses that seek to collimate or focus the divergent light beam emerging from the input signal optical fiber. At the output end of [the] a crossbar switch there is a [concomitant] corresponding requirement for a lens to ensure appropriate coupling of the optical beam to the output optical fiber. Again, there are great constraints on the scope of the physical dimensions of these devices.

Paragraph spanning pages 3 and 4:

A particular problem in these arrangements is [the fact that] the fixed nature of the micro-lenses which restricts the latitude of design available to optical engineers. It also puts constraints on the silicon micro-machined optical switching devices that typically form the heart of these [devices] crossbar switches, in that [these] the optical switching devices have to be fabricated such that they are optically matched to the fixed lenses in order to ensure minimum insertion losses and to restrict losses inside the devices.

First full paragraph on page 4:

[This] These design [restriction] restrictions would be [lifted] reduced if suitable adaptive micro-lenses were available. Since one of the [very] strengths of optical communications is the very wide bandwidth that it makes possible, there is every incentive to ensure that the optical devices and elements that are part of [such a] optical crossbar [switch] switches are commensurately fast, as this determines the rate at which routing and managed networking of the communication signals may be achieved. This issue applies not only to the sophisticated silicon devices in [the] a crossbar switch, but also to any adaptive micro-lenses within such a crossbar [switches] switch.

Second full paragraph on page 4:

Liquid crystal lenses to address some of these issues are known in the art. However, these devices have limited speed due to the inherently slow switching speed of the liquid crystal mechanism. [In a previous] Over the past decade, much collective effort was devoted to deformable macroscopic mirror devices for light projection systems, and in this respect piezoelectrically deformed lenses are known, but these clearly do not lend themselves to application in miniaturized optical crossbar switches.

First full paragraph on page 5:

In [respect it should be borne in mind that the user of] general, it is preferable for an adaptive optical element [would in general prefer] to maintain [the] its full dynamic range of adaptation, while simultaneously [demanding good] providing acceptable control over that range, most particularly, at the low end of the adaptation range. The concern [about this] related to the low end of the adaptation range is due to the fact that there are many optical systems in [where] which slight adaptation of focal lengths and the like, [have] may result in greatly disproportionate [resulting] effects within the overall optical systems.

Second full paragraph on page 5:

Another [semiconductor technology] approach for [obtaining] providing adaptive optical elements [is to employ] involves providing a membrane that is fixed at its perimeter, or that extends over a system of holes, and [to] then [deform] deforming one or more of these membranes using an electric field for electrostatic attraction. The typical device fabricated in this way [is] may be used to produce beam extinction or modulation by employing very tiny deformations [and] together with the principle of optical interference. Along with these general principles of operation, comes a general tendency of these devices to be inherently wavelength-sensitive.

After the text on page 6, add the following:

"FIG. 3 shows one possible embodiment for implementing an array of devices of the type shown in FIG. 1.

FIG. 4 shows another possible embodiment for implementing an array of devices of the type shown in FIG. 1."

First full paragraph on page 7:

FIG. 1 illustrates [the essence of the] a preferred embodiment of [the present invention as] a micro-electromechanical (MEMS) adaptive lens in accordance with the present invention. In a practical application such as an optical crossbar switch, the complete [device would] switch may have an array of elements of the type depicted here. For the sake of clarity, FIG. 1 shows a single adaptive lens element [or channel].

Second full paragraph on page 7:

Referring now to FIG. 1, flexible transparent electrode **1** is fashioned from a transparent and conductive material on top of flexible insulating layer **2**. [In the present application for letters patent, the term transparent refers to the material being optically transparent to wavelengths in the ultra-violet, visible and infrared ranges, and the term conductive is used to describe electrical conductivity.] The two layers are fashioned over a circular "pillbox" cavity in frame **3** of the MEMS device. The [section] portions of the two layers 1,2 that [is] are suspended over the cavity in frame **3** constitute [what we shall refer to in this application for letters patent as the] a transparent [membrane] "membrane" of the adaptive lens. Frame **3** represents [the] a fixed member of the [preferred embodiment of the present invention] MEMS device depicted in FIG. 1. Frame **3** may be fashioned from

silicon, poly-silicon, or a variety of other micro-machining-compatible materials, including silicon nitride.

Third full paragraph on page 7:

In the preferred embodiment of the present invention, flexible transparent electrode 1 is composed of indium tin oxide, but in the general case the material [employed for the] used to form flexible transparent electrode 1 (which provides a transmitting function) may be selected to suit the light being transmitted. It is also possible to [employ] add additional transparent layers [in the form of multi-layers,] to electrode 1; for example, anti-reflection layers can be added on top of transparent conductive layer 1.

Second full paragraph on page 8:

Flexible insulating transparent layer 2 is fashioned [on top of] such that its peripheral edges extend over frame 3. In the preferred embodiment of the present invention, it is preferred that the elastic properties of the [flexible] membrane be provided by flexible insulating transparent layer 2 in the form of a silicon nitride layer, which is optically transmissive at the wavelengths of concern, and that the electrode function of the membrane be provided by [the] an indium tin oxide layer constituting optically transparent conductive layer 1. This choice of materials is due in part to the fact that indium tin oxide has [superlative] desirable transmissive properties [whilst being] and is conductive, while silicon nitride is well established as a preferred material for flexible structures in MEMS devices due to its [relatively better] desirable elastic properties.

Third full paragraph on page 8:

The air space under flexible insulating transparent layer 2 [is] may be created using a sacrificial layer micro-machining process. Sacrificial layer techniques are well established in the microelectronics and micro-electromechanical systems (MEMS) fields and will not be detailed [herewith] herein. Transparent base electrode 6 [is] may be fashioned from a transparent conductive material, such as indium tin oxide, on top of transparent base 4 by standard deposition processes. Glass is the material of choice for transparent base 4 in the preferred embodiment of the present invention, which is directed at operating wavelengths of 1550 nm. Silicon of the appropriate purity may be employed as material from which to form transparent base 4 for wavelengths greater than the band gap of silicon. In the general case, the material used to form transparent base 4 is required to be transparent at the wavelength range of choice.

First full paragraph on page 9:

By fashioning flexible insulating transparent layer 2 from an insulating material, such as silicon nitride, flexible insulating layer 2 ensures electrical isolation between electrode 1 and transparent base electrode 6 in those cases where the material employed for the transparent base 4 [for frame 3] is conductive, such as will be the case for a base 4 made of silicon. The transparent membrane is therefore attached along its perimeter to the fixed member, frame 3. [, along its perimeter.] It is to be noted that the perimeter referred to here is that of the transparent membrane as a whole; [,] that is, the outer sections of layers 1 and 2 that are suspended over the "pillbox" cavity in frame 3.

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Second full paragraph on page 9:

There are many variations on the generic processes for fabricating micro-machined devices, such as the adaptive lens described in this preferred embodiment [and variations upon it]. A detailed description of a representative variant of this kind of processing of MEMS devices is given by Bifano et al in Optical [engineering] Engineering, Vol 36 (5), pp. 1354-1360 (May 1977).

Third full paragraph on page 9:

Access hole 7 [is] may be formed in frame 3 for two purposes. Firstly, it [serves] may serve as vent for trapped air when the transparent membrane of the device flexes, and secondly, it [is] may be employed to inject a refractive liquid 5 into the [air] space formed by the "pillbox" cavity in frame 3. In the preferred embodiment of the present invention, this refractive liquid 5 is preferably optical immersion oil. In general, the refractive liquid 5 is chosen to have a high refractive index, a low vapor pressure and as low a viscosity as possible. Optical immersion oil satisfies these requirements.

Paragraph spanning pages 9 and 10:

During fabrication, those surfaces of the device that fall inside the [pillbox "cavity"] "pillbox" cavity of frame 3, including transparent base electrode 6, [are] may be treated with an oleophobic material such as the low surface energy coatings employed as standard practice in MEMS fabrication to counter the well-known stiction problem. Since there is no preferential site for an injected oil droplet [under these circumstances] 5 on these oleophobic surfaces, the oil droplet 5 localizes itself in the middle of the [pillbox] "pillbox " cavity and fills the "pillbox" cavity to a degree determined by the droplet volume. The volume of refracted oil 5 selected in the preferred embodiment of the present invention, is such that the droplet [is conformal] 5 conforms with both the central portion of the transparent membrane and with the transparent base electrode 6.

First full paragraph on page 10:

The adaptive refractive function of the present invention is established by the combination of refractive liquid droplet 5, flexible insulating transparent layer 2, flexible transparent electrode 1, transparent base electrode [5] 6, and transparent base 4. In this [application for letters patent] description, we refer to the combination of transparent base electrode 6 and the transparent base 4 as the [transparent flat] "transparent flat". The refractive liquid droplet 5 therefore combines with the transparent membrane and the transparent flat to create an adaptive lens. The transparent membrane separates two refractive regions of differing refractive index. In the case of the preferred embodiment of the present invention, the two regions are air and optical immersion oil 5. In the general case, [it] the two regions of differing refractive index can be made up of a wide selection of substances and it is [specifically] generally possible to implement the present invention with any fluid on one of the two sides of the membrane. In this [application for letters patent] description, the term [refractive region] "refractive region" is therefore used to describe any body of material, gas, liquid, or other substance with a refractive index, specifically including free space and vacuum.

Second full paragraph on page 10:

It is evident that [these] the processes described herein may be used to create alternative detailed embodiments of the current invention that allow fabrication by planar processing in which [all] devices are fashioned within deposited layers, rather than etching the frame 3 of FIG. 1.

Second full paragraph on page 11:

In FIG.1, light beam **10** is shown [as] to be focused by lens **8**. Application of a voltage difference between electrodes **1** and **6** causes an electrostatic attractive force between the two electrodes **6** and **1**. This is a standard actuating technique employed in many MEMS devices. In the case of the preferred embodiment of the present invention, as shown in FIG.1, this electrostatic attractive force results in the transparent membrane deforming into the "pillbox" cavity of frame **3** in a substantially [concavely in] radially symmetrical fashion to form a concave surface. This deformation [is] and the resultant concave surface are shown exaggerated in FIG.1 for the sake of clarity.

Third full paragraph on page 11:

This deformation causes light beam **6** to be refracted, and change focus as the adaptive lens device assumes the shape of a half-concave lens and acquires a distinct negative focal length that becomes shorter with increasing applied voltage. In the preferred embodiment of the present invention, as shown in FIG. 1, [this] the negative focal length of the device has the effect of [diverging] causing a divergence in light beam **10** in opposition to the convergent effect of fixed focal length lens **8**. As the voltage is increased, the refractive [diverging effect of] divergence caused by the adaptive lens device increases.

Second full paragraph on page 12:

The purpose of this pre-stressing step is to obtain a radially symmetrical stress-field in the transparent membrane. This pre-stressing ensures that the transparent membrane is as flat as possible when no voltage is applied between electrodes **1** and **6**. [This] The flat surface of the transparent membrane in turn ensures that, at zero [induced refraction] applied voltage, the device will transmit light beam **10** with [the least] a minimum possible change in direction.

Third full paragraph on page 12:

[This] Minimizing the change in the propagation direction of optical beam **10** at zero applied voltage is an important requirement for adaptive lenses that are to function at the low-end of the adaptation range. The pre-stressing also provides the device with better control over membrane displacement, particularly at low voltages and small displacements. It furthermore ensures a high natural resonance frequency, which allows the device to be employed in systems that require rapidly varying adaptation.

Paragraph spanning pages 12 and 13:

In the case of the present invention, the stressed circular transparent membrane has a distinctive and well-controllable elastic deformation. MEMS devices are well

known to exhibit a so-called "snap-down" phenomenon. [This] Snap down occurs in cantilever devices [where] when the voltage applied to the device reaches a point at which the elastic restoring force of the cantilever is exceeded by the electrostatic attractive force and the cantilever physically snaps down onto the silicon substrate. The present invention, by virtue of the choice of circular membrane and pre-stressing, exhibits a deformation of the transparent membrane that is both radially symmetrical and much more controllable than cantilever devices. The choice of membrane materials, thickness and pre-stressing jointly determine the extent of [depression] deformation of the center of the membrane for a given applied voltage.

First full paragraph on page 13:

The elastic deformation of the transparent membrane is substantially concave in nature with the [detailed functional] precise shape being determined by the diameter and elastic properties of the transparent membrane, the lateral extent of electrode 6, [the elastic properties of the membrane,] and the [size] magnitude of the applied voltage.

Second full paragraph on page 13:

[The particular choice of employing a] A pre-stressed circular transparent membrane [addresses in particular the matter of the efficacy of the technique presented here in the case of] is particularly well suited for applications requiring low degrees of refraction. In such cases, the deformation of the transparent membrane is extremely small and yet has to be controlled.

First full paragraph on page 14:

Another object of the invention is to ensure that optimal control over the deformation is obtained, particularly at small deformations. With devices that are not pre-stressed, the [deformable] transparent membrane can assume a variety of deformations under the action of the voltage and the attenuation will [thereby] therefore be difficult to control. By pre-stressing the membrane, the device is effectively being biased towards a flat orientation so as to achieve maximal optical throughput and minimum [lens] refractive effect at zero applied voltage.

First full paragraph on page 15:

In the more general case, the perimeter of the membrane [is] need not be circular, but [is] may be of any smoothly varying two-dimensional shape. This allows the membrane to be pre-stressed without inducing areas of excessive local stress, such as will occur at sharp corners. One particular alternative embodiment, in this respect, is a structure that is substantially rectangular with rounded corners and which will, near the center of its extent, behave as a cylindrical lens. Such elements are important for use with light sources that have differing divergence in perpendicular directions, such as side-emitting semiconductor lasers.

Second full paragraph on page 15:

[It is evident from the preferred embodiment of the present invention, that, since the] The device may be adjusted according to the light source used. In particular, the voltage on the device may be changed to compensate for the variation of

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refractive index with the wavelength of the source, thereby keeping focal lengths the same. The wavelength limitations involved pertain only to the choice of materials. This matter is in the hands of the designer of products embodying the invention and does not limit the invention itself in respect of wavelength.

Third full paragraph on page 15:

No feedback is employed in the preferred embodiment of the present invention, as the addition of such a function adds to the complexity and cost of the device. [This should be seen against the background of one of the objects of the invention being to obtain a low cost device.] However, feedback can be incorporated in an alternative embodiment of the present invention by a number of different means. These include capacitively measuring the membrane position or sampling the light going in and coming out and adjusting the applied voltage and consequent deformation based on this measurement.

First full paragraph on page 16:

The actuation of the membrane may be linearized or given any desirable transfer function. The term [linearization] "linearization" is used in this [application for letters patent] description to describe any collection of steps or mechanisms that leads to the [actuation] behavior of the [actuator] device being mathematically described by a set of linear equations. One way in which this may be achieved is by means of lookup tables relating the input actuation and output deformation of the membrane. A linearization look-up table can be included in a semiconductor memory structure, which may be incorporated on the same contiguous piece of silicon wafer as the adaptive lens itself. In a co-pending United States patent application [for letters patent under the title] entitled "Method for linearization of an actuator via force gradient modification" (US serial number 09/813839) which is hereby incorporated by reference, this kind of mechanism is described in detail [and is hereby incorporated in full].

Paragraph spanning pages 16 and 17:

FIG. 2 shows a block diagram of such an alternative embodiment of the present invention in which the preferred embodiment shown in FIG. 1, is incorporated as adaptive lens **12**, with impinging light beam **10**. [This adaptive] Adaptive lens **12** can also be controlled via control signal **13** which is adapted by linearization module **17** and provided to the adaptive lens **12** as actuation signal **14**. The deformation of the membrane of adaptive lens **12** is sensed by position sensing means **15**, which provides linearization module **17** with a feedback signal **16**. Input power **18**, typically 5 VDC, 12 VDC, or 48 VDC, is provided to the whole system and power supply **19** uses this energy source to provide the linearization module **17**, and thereby adaptive lens **12**, with a higher voltage **20**, which may typically be between 50 and 100 V. Linearization module **17** generates the actuation signal **14** as a voltage, typically 0-100V. The linearization module can be of the analog type or, preferably, digital with a lookup-table and programmable with an arbitrary transfer function. Such methods are well known in the art. For greater long-term stability a feedback sensor **15** measures the actual position and/or performance of the adaptive lens **12** and further modifies the actuation signal **14**.

First full paragraph on page 17:

FIG.1 shows one adaptive lens element with an associated light source and collimating lens. This embodiment of the present invention may be repeated in two dimensions in a plane to create an array of adaptive lenses. It is possible to fabricate all of these devices on a single contiguous section of silicon wafer using standard MEMS technology as described and referred to above. In this way, it is [therefore] possible to generate [one-] one or two-dimensional arrays of adaptive lenses for managing optical beams from a multiplicity of optical channels. Any or all of these may be implemented with the feedback and control mechanisms shown in FIG. 2 in order to ensure adequate control over the refraction process.

Second full paragraph on page 17:

A number of different ways exist to combine these individual adaptive elements. In FIG 3 and FIG.4, two ways are shown in which such elements may be combined. For the sake of clarity, FIG. 3 and FIG. 4 show arrays of adaptive devices [combinations] in only one direction, [are shown,] but it will be clear to those skilled in the art, that the same principles may be applied to create [two dimensional] two-dimensional arrays. In both cases the numbering of components, for the sake of clarity, is the same as in FIG.1. In both FIG.3 and FIG. 4, use is made of a communal transparent base electrode 6. In the case of the embodiment shown in FIG.3, each element has its own refractive liquid droplet 5 in a dedicated "pillbox" structure, similar to FIG.1. However, in the case of the embodiment shown in FIG.4, all the elements in the array share a communal droplet of refractive liquid 5. The individual refractive lenses are formed by localized deformation of the droplet underneath a particular transparent membrane that is deformed by an applied voltage.

In the claims

1. (Once Amended) A method for varying [the] a direction of a light beam passing through a micro-machined device, said method comprising

   [a.] directing said light beam through a transparent membrane separating two refractive regions, [of differing] each of said refractive regions comprising a fluid with a different refractive index, said membrane being attached at its perimeter to a fixed member; [,] and,

   [b. deforming said membrane in concave fashion] inducing a deformation of said membrane, thereby increasing a thickness of a first one of said refractive regions and correspondingly decreasing a thickness of a second one of said refractive regions.

7. (Once Amended) A method as in claim 4, wherein said membrane is one of a plurality of substantially identical membranes fabricated on one contiguous section of silicon wafer [, said membrane being] and each one of said plurality of membranes is capable of being deformed independently of any other one of said [multiplicity] plurality of membranes.

8. (Once Amended) A method as in claim 7, wherein more than one of said plurality of [substantially identical] membranes are in contact with [the same] a single body of refractive liquid.

9. (Once Amended) A method as in [any of the above claims, wherein said refraction is controlled via] claim 1, comprising controlling the direction of the light beam passing through the micro-machined device using a feedback method.

10. (Once Amended) A method as in claim 9, wherein said feedback method comprises [the use of] generating a signal indicative of [the extent of] one or more of: [said refraction] the direction of the light beam passing through the micro-machined device, an amount of said deformation, [the] an amount of electrostatic force between said membrane and an electrode on said fixed member, and [the] an amount of electrical capacitance between said membrane and said electrode.

11. (Once Amended) A method as in claim 10, wherein said feedback method comprises linearization [of said deformation process] of the deformation of said membrane.

12. (Once Amended) A method as in claim 11, wherein said linearization [is achieved by the use of] comprises using data from a look-up [tables] table.

14. (Once Amended) An adaptive lens [for refracting a light beam transiting through] in a micro-machined device, said adaptive lens comprising a deformable transparent membrane separating two refractive regions, [of differing] each of said refractive regions comprising a fluid with a different refractive index, [said transparent membrane being deformable to vary by said deformation the extent of said refraction] wherein an amount of deformation of said transparent membrane determines an amount of refraction caused to a light beam transmitted by said adaptive lens.

15. (Once Amended) An adaptive lens as in claim 14, wherein [said] deformation of said membrane is induced by electrostatic force.

20. (Once Amended) An adaptive lens as in [any one of claim 3, claim 4, claim 5, claim 6, claim 7 or claim 8] claim 14, wherein said deformable transparent membrane is one of a plurality of substantially identical membranes fabricated on one contiguous section of silicon wafer [, said membrane being] and each one of said plurality of membranes is capable of being deformed independently of any other one of said [multiplicity] plurality of membranes.

21. (Once Amended) An adaptive lens as in claim 20, wherein more than one of said plurality of [substantially identical] membranes are in contact with [the same] a single body of refractive liquid.

27. (Once Amended) An adaptive lens as in [any one of claim 14 or] claim 22 wherein said degree of refraction is controlled via a feedback mechanism.

28. (Once Amended) An adaptive lens as in claim 27, wherein said feedback mechanism comprises a feedback sensor, which indicates [indicating the extent of] one or more of: said degree of refraction, an amount of said [deformation] curvature, [the] an amount of electrostatic force between said membrane and an electrode on said fixed member, and [the] an amount of electrical capacitance between said membrane and said electrode.

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